High-Efficiency Receivers for Supercritical CO_2 Recompression Cycles

Brayton Energy, LLC

Award Number: DE-EE0005799 | July 15, 2013 | Sullivan

PROJECT OBJECTIVES

Goal:

- High performance supercritical carbon dioxide (sCO_2) Brayton-cycle engines are currently under development and promise to significantly reduce LCOE via high cycle efficiency.
- The proposed receiver uses sCO_2 as the heat transfer fluid, enabling these highly efficient engines to be used in concentrated solar power (CSP) applications.

Innovation:

- A solar receiver adapted to the sCO_2 recompression cycle represents a major advancement in technology over the state-of-the-art in CSP systems, and will contribute directly to the SunShot goal of 6¢/kW-hr.

Quarterly Milestones (in progress):

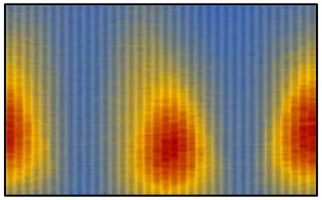
- Define an sCO_2 Brayton Engine Cycle Model that can be used to specify receiver statepoints (initial specification received)

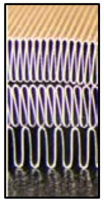
APPROACH

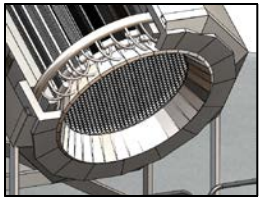
- Numerical Modeling is used to capture the highly nonlinear physical properties of sCO_2 within the highly-effective enhanced heat transfer. region, where fluid temperature is changing rapidly
- Manufacturing Trials are used to demonstrate reliable methods for fabricating the enhanced heat transfer surfaces that will reside within the high-flux environment of the receiver
- Historical Data from a baseline installation location will be used to provide a year-long solar profile which feeds into the overall performance model to produce an annualized performance metric
- Subcomponents will undergo simulated operating conditions in test rigs to demonstrate their suitability and performance
- Ultimately a prototype receiver will be tested on sun in a power-tower application to demonstrate the full receiver system performance

KEY RESULTS AND OUTCOMES

- Absorber architecture defined capable of (a) withstanding cycle pressures and (b) maintaining acceptable material temperatures necessary for 90,000 hr, 10,000 cycle life, c) bettering SunShot cost target.
- Albuquerque solar conditions applied to Sandia solar field to establish flux profiles on candidate cavity shapes
- Cavity shape selected with aid of thermo-hydraulic absorber models
- Annual/diurnal solar conditions and resulting TIT-fixed flow rates have been used to evaluate the off-design receiver performance
- High temperature furnace rig modifications complete.







NEXT MILESTONES

- Prepare Ni-alloy absorber panel sections for test
- Initiate creep-rupture trials of absorber panel sections.
- Conduct pressure-fatigue tests of absorber-panel sections
- Validate thermo-mechanical model with test data.
- Modify radiant test rig.